City of San Saba, Texas

Water and Wastewater Systems Study Update

PRELIMINARY

August 1992

THE HOGAN CORPORATION
Engineers • Planners • Consultants
Dallas • Austin

(e) Pumps deficient in capacity; for each 10% deficiency .... .01

Minimum capacity of pumping units to be 500 GPM at 150-foot minimum pressure head each, and in towns where the capacity of the pumps on the basis of 130 gallons per capita per 24 hours, is adequate (towns of 5,540 or less) but less than 500 GPM, reduce charge (e) 50%.

NOTE: All pumping units to be designed at a minimum pressure head of 150 feet, taking suction from adequate reservoirs maintained full by adequate water supply pumps.

(f) Pressure at hydrants less than needed for satisfactory fire flows .... .05

(g) If less than 75% but over 40% of services to consumers metered....... .01

(h) If less than 40% of services to consumers metered.................... .02

(i) No flow or pressure measuring devices where required .... .01

NOTE: Applicable in all cases where population is more than 10,000.

(j) Power for service pumps not according to standards .... .03

Where pumps are driven by satisfactory internal combustion engines of a standard design, charge (j) may be reduced to...................... .01

Where electric motors are used and current is furnished from a generating plant or sub-station, the equipment of which is such as to warrant continuous service, and a single electric circuit is available but does not exceed approximately 5 miles in length, and is of satisfactory construction and not seriously exposed mechanically or otherwise, and wiring is in accordance with the National Electrical Code, charge (j) may be reduced to... .01

In the case of electric power where current is secured from a generating station or sub-station whose equipment, construction, capacity and location are such as to warrant continuous operation, and where duplicate electric circuits are installed -- such circuits to be duplicate from source to pump station switches and to follow different routes -- and where wiring is in accordance with the National Electrical Code, charge (j) may be waived.

Where two independent sources of power are available, one of which is under the complete control of the city or town, and tested semi-monthly, and both of which are satisfactory and reliable, charge (j) may be waived, and the charges under 1(c) and 1(d) reduced .... .01

(k) Pumping equipment not properly maintained......................... .05

2. WATER SUPPLY

The estimated amount of water required for household and manufacturing purposes plus fire protection is 130 gallons per capita.

(a) If not according to standard, for each 5% below requirements .... .01

Where water supply is deficient, the above penalty may be avoided by the installation of a storage reservoir with a capacity equivalent to a 24-hour supply, on the basis of 130 gallons per capita. Such reservoir to be provided with separate gated suction lines and the full capacity reserved at all times for fire purposes only. Should it be desired to build a larger reservoir in order that same may be used also for domestic pumping, separate lines for domestic and fire purposes must be provided and so arranged that the required reserve will be maintained at all times. For a reservoir smaller than the requirements but arranged as outlined above, to provide a reserve supply at all times for fire protection, reduce the charge for deficient water supply in the proportion that the capacity of the reservoir bears to the required capacity, but in no case is the reservoir to be less than 50,000 gallons capacity. Where the water supply is inadequate at certain periods only, charge to be a percentage of 20 cents, determined by the proportion that the period of inadequacy bears to the entire year. Where water supply is of seasonable nature or of doubtful reliability, a minimum charge of .02 shall be applied.

(b) Ground storage basin or reservoir; for each deficiency of 20% .... .01

The capacity of the ground basin or reservoir to be based on a 24-hour supply and 130 gallons per capita, with a minimum capacity in all cases of 50,000 gallons. Ground storage facilities to be located so as to be available for use by service pumping units in a manner satisfactory to the State Board of Insurance.

It will be noted that the charge under (a) and the reservoirs described thereunder are separate and distinct from the ground storage basin required under (b), and the two charges are cumulative.

3. ELEVATED TANK, STANDPIPE OR ELEVATED STORAGE

For each 20% deficiency or fraction thereof .... .01

(The required capacity of elevated storage is the equivalent of 10 hours' supply, based upon the requirement of 130 gallons per capita per 24 hours.) 54 gpc

In the case of standpipes, only that part of the capacity which is elevated 75 feet or more above the mercantile district is to be considered, unless the fire department is equipped with an adequate number of fire department pumpers, in which case that part of the capacity elevated 25 feet or more may be considered. In cities and towns having duplicate pumping units of adequate size and in no case less than 500 GPM each, the above charge may be reduced 50%.

In cities and towns having duplicate pumping units of adequate size and not less than 10 million gallons per day each, the above charge may be reduced 75%.

Elevated tanks erected subsequent to the adoption of this schedule must be elevated at least 100 feet above the mercantile district in order to secure recognition, and in no case shall the bottom of the tank be less than 100 feet above the mercantile ground elevation.

4. WATER MAINS

(a) Supply main not in duplicate .... .02

If the supply main from the main pumping station to the mercantile district and elevated tank is less than one mile in length, charge 4 (a) may be reduced to 1¢. The main from the water primary supply to the main city service pumping station must also satisfy this requirement.

(b) Supply main inadequate in size, for each 15% deficiency or major fraction thereof .... .01

Maximum charge under (b), 5¢. Minimum charge under (b) where supply main is smaller than 8 inches, to be 2¢. The size of the supply mains should be such that the required volume of water based on population and 130 gallons per capita per day is available from the main pumping stations.

NOTE: Charges (a) and (b) are cumulative.

(c) Supply mains in duplicate, but one main deficient in size .... .01

Charge (c) is applicable where a duplicate supply main has been installed and is not adequate in size but capable of delivering a satisfactory volume of water during a temporary breakdown of principal supply main.

(d) For each 10% of water mains less than 8 inches in mercantile portion of city or town .... .01

NOTE: Discretion to be used in applying above charge where a system is "gridironed" and main leads are 8 inches or over, gridironed by 6-inch mains.

(e) For each 10% of mains deficient in size in residence sections of city or town .... .01

NOTE 1: All portions of 6-inch looped mains in excess of 3,500 feet to be charged for. All portions of 6-inch dead ends in excess of 1,800 feet to be charged for. All 4-inch dead ends to be charged for. In the case of 4-inch looped or gridironed mains, charge to be applied for all portions exceeding 600 feet in length, all such excess to be considered in computing the deficiency.

NOTE 2: In cities of 25,000 population or over, deficiency penalty shall be calculated on basis of actual standard fire flow tables. In all cities or towns, regardless of population, where deficiency in flow pressures is indicated, deficiency may be calculated as outlined above.

The deficiencies in cities and towns to be based on the following fire flows:

Principal mercantile and industrial areas .... 3,000 GPM
Light mercantile areas .... 1,500 GPM
Congested residential areas .... 750 GPM
Scattered residential areas .... 500 GPM

All fire flows to be calculated with 20 pound residual pressures.

(f) If pipe or fittings of a type of material not listed by Underwriters Laboratories or Factory Mutual for fire service .... .05

5. FIRE HYDRANTS

(a) Deficient in number in mercantile district, for each 15% or fraction thereof .... .01

Maximum charge not to exceed .04.

(b) Deficient in number in residential sections, for each 15% or fraction thereof .... .01

Maximum charge not to exceed .04.

(c) For each 1% of hydrants supplied from mains smaller than required.... .01

(d) If over 25% of hydrants in mercantile district or in residential sections of one-way type .... .02

(e) If over 20% of hydrants in mercantile district of two-way type .... .02

NOTE: Charge applicable to cities and towns over 3,000 population.

(f) Hydrants not properly maintained .... .02

(g) National standard hose threads not properly maintained and/or valve openings less than standard .... .02

THE HOGAN CORPORATION

Engineers • Planners

August 11, 1992

Honorable Mayor and City Council
City of San Saba
303 South Clear
San Saba, Texas 76877

Re: Waterworks and Wastewater Systems Study Update

Gentlemen and Mrs. Miffleton:

Submitted herewith is our report on the Waterworks and Wastewater Systems Study Update for the City of San Saba, Texas in accordance with the letter agreement for this project, approved on July 29, 1992.

The results of the planning and the recommendations to be pursued are presented on the following pages for your consideration and implementation.

We express our special appreciation to City Manager Darrin Barker and his Staff for furnishing existing maps and data pertaining to the City's existing waterworks and wastewater systems, and for their splendid cooperation throughout the entire development and preparation of this study.

It has been a pleasure to perform this study for you, and we look forward to assisting you with the development of the projects proposed herein.

Respectfully submitted,

THE HOGAN CORPORATION

Robert E. Hogan, P.E.
President

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Member, American Consulting Engineers Council

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City of San Saba, Texas

Water and Wastewater Systems Study Update

August 1992

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SAN SABA
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Marcus D. Amthor

Mayor Pro-Tem

Deryl Hoyt

Aldermen

Jan Huffstetler
Maxine Miffleton
Sam Miller
Marvin Riggs

City Manager

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REPORT ON

WATERWORKS AND WASTEWATER SYSTEMS STUDY

FOR THE

CITY OF SAN SABA, TEXAS

I. INTRODUCTION

A. Authorization of Report

By agreement, dated July 29, 1992, the City of San Saba, Texas, authorized an engineering study on the update of its waterworks and wastewater systems that will provide the adequacy and reliability necessary for service for the area within the present City Limits, which is herein called the Study Area.

B. General Requirements

The proposed plan and program of implementation presented herein have been prepared in coordination with the various individuals and entities representing the City of San Saba and other related local and regional planning entities and extend to all those areas defined by the City as the Study Area at the time of the authorization of this report.

All available maps, materials, plans, reports, and other data furnished by the City, pertinent to the study and analysis of the City's waterworks and wastewater systems, have been reviewed. All known definitions and standard design criteria of governing agencies, such as the Texas State Department of Health, the State Board of Insurance, the Texas Commission on Fire Protection, the Texas Water Commission, and the U. S. Environmental Protection Agency, have been used in developing this study and report.

C. Purpose and Scope

The purpose of this study is to develop a waterworks and wastewater systems master plan update to serve the Study Area.

The scope of this study includes the following:

Waterworks Plan

1. *Projected water use demand rates for supplies of treated water, storage, pumping and distribution facilities*
2. *General locations and approximate sizes of water supply facilities*
3. *General locations and approximate sizes of ground storage tanks, elevated storage tanks, and high service pumping stations*
4. *Approximate sizes and general locations of major water mains*
5. *Criteria for sizing and locating water mains, fire hydrants, and gate valves*

Wastewater Plan

1. *Projected wastewater flows for determining sizes of wastewater facilities*
2. *Approximate sizes and general locations of proposed facilities for disposal of wastewater from the City*
3. *Approximate sizes and general locations of proposed sewer mains, lift stations, and force mains*
4. *Criteria for sizing and locating sewer mains, manholes, and other facilities.*

Where practicable, alternate solutions and plans will be determined, and recommendations will be presented for construction of those facilities considered to be the best and most feasible. Priorities and cost projections will be developed for those improvements to be constructed in sequential order.

II. LAND-USE AND POPULATION

A. Land-Use

The land-use patterns of San Saba in the past have revealed commercial development around the County Courthouse and downtown area as well as westward along U.S. Highway 190 and northward along State Highway 16. Industrial establishments have developed along the A.T. & S.F. Railroad. Residential subdivisions have occurred principally westward and southward from the downtown area.

It is anticipated that land-use patterns in the future will continue to expand from those already established.

The City should be concerned, however, that several of the large water users and contributors of large wastewater flows have located in the western and northern sectors of the City. The water supply and wastewater treatment facilities are located on the east side of the City, requiring that facilities have sufficient capacity to move the water westward across the City and then move the wastewater eastward back across the City. In the future, consideration should be given to locating large users of water and dischargers of wastewater on the east side of the City.

B. Population

The number of people to be served and their per capita consumption of water, coupled with allowances for fire-flow and water demands to industries, schools, businesses, etc., are very basic considerations in waterworks and wastewater systems planning. Each *community has its own particular characteristics which will govern its growth, but, despite the limitations, projections of future growth must be made for planning and expanding the systems.*

It is generally advisable to make conservative estimates of growth in order to assure that there will be no unwarranted expenditures of capital funds and to plan facilities to permit economical expansion of the systems in the event that growth is in excess of that anticipated.

According to U.S. Census records over the past 60 years, the population of San Saba has fluctuated from a low of 2,240 in 1930 to a high of 3,400 in 1950. In 1990, the population count was 2,626.

The Comprehensive Plan for the City of San Saba, Texas, dated May 1991, shows a projected population of 3,060 in Year 2000 and 3,550 in Year 2010. Because of the opening of the State Prison and the planned expansions of several local industries, City officials now feel that a population of 3,350 can be realized by Year 1998, and the projected population for Year 2012 is 5,500.

From the present to Year 1998, the population increase will be at the average rate of approximately 3.5% per year. In the succeeding 14 years, the increase will accelerate at the average rate of approximately 4.5%. These are ambitious projections but are attainable with an aggressive program for economic development and the provision of adequate utilities and sufficient infrastructure.

III. WATERWORKS SYSTEM

A. Water Demands

Water demands are generally referred to in the following terminology.

1. Average Daily Demand

This is expressed in million gallons per day (mgd) for the entire water system and represents the daily demand averaged over a period of one year.

2. Per Capita Demand

This is expressed in gallons per capita per day (gpcd) and represents the daily water demand per person averaged over a period of one year.

3. Maximum Daily Demand

This is expressed in mgd and represents the maximum amount of water used in the system in one 24-hour period in a given year.

4. Peak Hourly Demand

This is expressed in mgd and represents the rate at which water is used during the hours of maximum usage in a given year.

5. Minimum Hourly Demand

This is expressed in mgd and represents a condition at which the demands in consumption are the lowest and the period of time at which the pressures may be the greatest and at which the elevated tanks are being refilled after periods of maximum usage.

6. Fire-Flow

This is usually expressed in gallons per minute (gpm) and represents the amount of water required for fire protection in addition to the water demands for consumption. The determination of the required fire-flow is based upon an analysis of the structures in the City, noting types of construction, ground floor area, building height in stories, occupancy, existence of automatic sprinkler systems, and exposure to surrounding development.

The three basic demand rates normally recognized as design parameters in evaluating a waterworks system are the average annual daily demand, the maximum daily demand, and the peak hourly demand. In this study, the minimum hourly demand will at least be considered, because occasionally during this condition the highest head on the high service pumps will be experienced when water is being pumped completely through the system. During the minimum hourly demand condition, the pumps will be pumping against maximum facility pressures when the elevated tanks are being filled, which must occur within a short period of time in the early morning hours.

It is generally accepted practice that the treated water supply source must satisfy the maximum daily demands of the system. The high service pumps should be sized to meet a capacity of at least 1.25 times the maximum daily demand rates so that the maximum release from the elevated tanks will not lower their water levels below half full, thus preserving an amount of reserve for major fires with adequate residual pressure.

The distribution system, in conjunction with the high service pumps and the elevated storage tanks, must have the capacity to meet the peak hourly demands of the system.

A review of the City's water usage records of the last three years revealed that the average per capita usage varied from 182.2 gpcd to 204.8 gpcd. These did include all pumpage flows, including major breaks during these periods.

It is felt that there will continue to be increases in the per capita water usage in the future, which will be attributable to a greater public acceptance and use of water consuming devices, such as automatic dishwashers, lawn sprinkler systems, clothes washers, and garbage disposals, and because of increased commercial and industrial uses of water. Even though the practice of water conservation will be encouraged and enforced, there will continue to be a tendency to use more water in the future as greater quantities and better pressures become available with improvements to the system.

It is recommended that the projected average per capita usage be 210 gpcd for Year 1998 and 220 gpcd for Year 2012. Table No. III-1 includes the projected average daily usages for San Saba.

TABLE NO. III-1

PROJECTED AVERAGE PER CAPITA USAGE (gpcd)

Year	Projected Population	Average Usage
1998	3,350	210
2012	5,500	220

The ratio of maximum daily usage to average daily usage over the last three years in San Saba has varied between 2.64 and 2.73. This ratio is very similar to that experienced in other cities in the general size of San Saba. It is therefore recommended that the ratio of maximum daily demand to average daily demand of 2.7 be used for future planning in San Saba.

Usually the greatest draft upon a water system will occur in the late afternoon hours of June, July, and August and will frequently reach a peak hourly water requirement of 400 percent of the average daily demand. This percentage is recommended for future planning in San Saba.

The projected population and the projected per capita usage figures recommended herein were utilized to prepare the following TABLE NO. III-2.

TABLE NO. III-2

PROJECTED WATER DEMANDS (mgd)

Year	Projected Population	Average Daily	Maximum Daily	Peak Hourly Rate
1998	3,350	0.70	1.34 1.90	2.28 2.81
2012	5,500	1.21	3.27	4.84

For planning and design purposes, the water demands for the future systems are projected according to the type and density of development anticipated within the grid system of large diameter mains (8 inches in diameter or larger). As presented in PART II, future land-use and densities of population were used in determining the water demands, and water usages have been projected through the Year 2012 which will include anticipated flows for all types of land uses, including industry. As future industries are located in San Saba, particular attention should be given to their water demands and how the future waterworks system might meet those demands.

The water demands required for community facilities (parks, cemeteries, elementary, middle and high schools, etc.), other than hospitals, usually occur at times other than during the periods of greatest usage. Therefore, since the water distribution system will be designed for the highest rate of water usage, all of the water requirements for the various developments should be satisfied.

Should the City consider furnishing water to future outside customers, the water supply should be delivered at the customer's <u>maximum daily demand rate</u> into a ground *storage reservoir which should provide for a complete air-gap between the systems. Each outside customer must, then, provide its own means of furnishing water flows and pressure to meet its peak water demands. The water delivery should be regulated by a rate-of-flow controller.*

A system that is capable of providing adequate water at reasonable pressures during the time of maximum usage and also being able to replenish the storage tanks during periods of minimum usage should be sufficient for any condition; however, the water demands for a major fire could be the exception. For this reason, the system's ability to handle water demands with fire-flows should be considered, although, in most instances, the fire-flow and water usage requirements are usually less than the other water demand conditions in medium to large cities.

The State Board of Insurance and the Fire Prevention and Engineering Bureau of Texas (FPEB) conduct surveys of cities' waterworks facilities and related fire defenses. Under Public Fire Protection Standards, the required capacity of a water system, with consideration of storage, is determined by the rate of consumption, plus a rate of flow for fire protection for a required period of time. The required rate and duration of fire-flow was determined by the conditions and occupancies of structures in the City. According to the comments of FPEB, it was indicated that the structural conditions and occupancies of industrial and commercial buildings in San Saba would require a fire-flow rate of approximately 3,000 gallons per minute, or 4.32 million gallons per day.

In determining the critical condition for water demand in planning the future water distribution system, a comparison was made of the estimated demand during the peak hourly usage condition versus the estimated demand during the maximum daily usage plus the estimated requirements for fire-flow. The comparison of the two water demands is as follows:

TABLE NO. III-3

WATER DISTRIBUTION SYSTEM DEMAND
MAXIMUM DAILY DEMAND + FIRE-FLOW VS. PEAK HOURLY DEMAND

Year	Maximum Daily Demand + Fire-Flow (mgd)	Peak Hourly Demand (mgd)
1998	1.90 + 4.32 = 6.22	2.81
2012	3.27 + 4.32 = 7.59	4.84

?

The above comparison indicates that the maximum daily demand plus fire-flow condition for the total anticipated development through the Year 2012 exceeds the requirements of the peak hourly demand. Therefore, the future water distribution system of the City should be planned and designed accordingly.

B. Existing Waterworks System

1. Supply

According to the City's report on Water System Study, Wastewater System Study, Drainage System Study, dated August 1991, "the City's water source is a fresh water spring on Mill Creek Branch. This spring flows into a man-made lake named Mill Pond *from which it discharges into Mill Creek Branch and flows to its confluence with the San Saba River.*

The City's four wells are shallow and tap into this spring. The spring has been closely monitored for several years by the United States Geographical Service. The spring's flow as measured at the flume at the dam exceeds 7.5 cubic feet per second (5 million gallons per day). This flow is maintained even in extremely dry years. Therefore, supply greatly exceeds any anticipated future requirements."

Because of the topography of the San Saba area and the trend toward developing into higher elevations, the City has already taken steps to divide the water distribution system and operate it as two separate pressure planes.

Two wells with a capacity of 400 gpm each pump water into a reinforced concrete ground storage tank for the lower level system, while two other wells, each with a capacity of 600 gpm pump water into a steel ground storage tank for the upper level system, all located near Mill Pond.

The City should be certain that it does possess rights to the water from the spring and should make every effort to see that those water rights are retained. It is not uncommon for cities in Texas to make projections for long range water supplies 50 years hence and to obtain those water rights so that their future can be assured. It is recommended that the City of San Saba take similar action for its future water supply.

2. Treatment

a. Water Treatment Plant

San Saba's water source is a spring flowing from the Ellenberger-San Saba Aquifer into a reservoir (Mill Pond) prior to overflowing into Mill Creek and the San Saba River. The City has four shallow wells that tap this spring, and, currently, water is used directly without treatment other than chlorination for disinfection.

A significant new regulation coming from the Safe Drinking Water Act Amendment of 1986 (SDWA), is the Texas Surface Water Treatment Rule. This rule requires that public water supplies that utilize source groundwater, under the influence of surface water, must provide filtration within 18 months of notification by the Texas Water Commission (TWC).

Systems relying on shallow wells in flowing aquifers, recharged with surface runoff, have the potential to be contaminated by suspended matter and microorganisms. This is evidenced by turbidity (suspended particles) which is an indication of contamination that also reduces the effectiveness of disinfection.

Presently, it is understood that the TWC has determined that San Saba's wells are not directly influenced by surface water; therefore, filtration is not currently required. However, the City's water source has some problems that should be studied further.

Texas and the U.S. EPA have established Maximum Constituent Levels (MCL's) for many possible contaminants of public water supplies. In San Saba, radio-chemical contamination by naturally occurring radium, an ultra-trace contaminant, exceeds the State and EPA MCL of 5 pCi/L (pico Curies/liter). This level of radiation is equivalent to 5 X 10^{-9} mg/L of Ra ^{226}. Currently, under a bilateral agreement with the Texas Water Commission, no treatment for radium is required. However, it would be beneficial to consider the removal of radium in the selection of any water treatment process considered for San Saba because the EPA's nonenforceable health goal (MCLG) for radium is zero.

pH Adjustment

The City's water is very high in dissolved CO_2 and is therefore acidic. This could cause corrosion of water meters, iron pipelines, copper service lines, and pumps. While corrosion is an obvious problem in itself, corrosion of piping is also a significant source of dissolved lead and copper in drinking water.

Another new regulation, as a result of the SDWA, is the rule for maximum levels of lead and copper in drinking water. Currently, only larger systems are affected; however, by July of 1993, systems servicing populations below 3,300 will be required to monitor for lead and copper. Levels exceeding 0.015 mg/L for lead and 1.3 mg/L for copper will require municipalities to initiate treatment for corrosion control.

San Saba's water is also very hard, 325 mg/L (as $CaCO_3$). Ideal water would have a hardness of 85 to 150 mg/L.

3. Storage

Water storage for the City is currently provided as follows:

a. Ground Storage

According to the records of the State Board of Insurance, the reinforced concrete ground storage tank has a diameter of 38 feet and a water depth of 11.2 feet (capacity 95,000 gallons), and the steel tank has a diameter of 29 feet and a water depth of 16 feet (capacity 79,100 gallons).

There is a cold joint seam which is evident horizontally around the outside of the concrete tank which constantly allows seepage losses. The steel tank was constructed more recently and seems to be in good condition.

b. Elevated Storage

Elevated storage is provided in the lower level system by a steel elevated reservoir (or standpipe) located in the southwestern sector of the City. This tank is known as the "Silver Elevated Reservoir".

According to the records of the State Board of Insurance, this tank has a diameter of 38.2 feet and a water depth of 53 feet (capacity 454,355 gallons). It has a base elevation of 1,287 feet above mean sea level (M.S.L.) which sets the overflow at elevation 1,340 feet.

The "Gold Elevated Reservoir" was constructed in 1986 with a diameter of 38 feet and a water depth of 56 feet (capacity 475,059 gallons). This steel tank is located in the southwestern sector of the City, also, and furnishes elevated storage for the upper level system. Its base was constructed at elevation 1,360 feet, which sets the overflow elevation at 1,416 feet above M.S.L.

4. *High Service Pumping Facilities*

The existing high service pumping facilities are currently located at the Mill Pond. A list of the four (4) pumps and their rated capacities is as follows:

Low Level System

One rated at 750 gpm, with 40 horsepower (HP) motor

One rated at 1,000 gpm, with 75 HP motor

Lower Level System

Two rated at 500 gpm each, and each with 50 *HP motors*

With the largest pump out of service in each operating level, the firm high service capacity in the lower level system is 1.08 mgd and 0.72 mgd in the upper level system.

5. *Distribution System*

The network of existing water distribution mains is comprised of approximately 17 miles of pipe in the lower level system and almost 12 miles of pipe in the upper level system. The sizes vary from 8 inches to 2 inches in diameter.

Elevation of service in both the lower level system and the upper level system vary from a low of 1,180 feet to a high of 1,300 feet above M.S.L.

A windshield survey revealed a total of approximately 125 fire hydrants located throughout the City. Of these, approximately 45 are considered to be substandard. Most of the substandard fire hydrants are located in the County Courthouse and downtown area, near the schools, and along Story, Commerce, Wallace, and Brown Streets.

The four-inch mains in Dry and Wallace Streets, and the fact that some of the six-inch mains are not cross-connected at proper intervals, are causing the City to receive a charge on its fire key rate.

C. Proposed Waterworks System

1. General

The scope of this study for the analysis of the waterworks system includes five (5) basic elements--supply, treatment, storage, high service pumping, and distribution. Each component of the system has been analyzed and is planned for an interaction responding to the projected maximum demands of the system as previously established herein.

In addition, minimum standards and recommendations of design criteria of the Texas Water Commission, the State Board of Insurance, and the Fire Prevention and Engineering Bureau of Texas were considered and incorporated where applicable in the planning for the future waterworks system.

2. *Supply*

It is anticipated that the City will continue to rely on the Mill Creek Branch spring for its water supply. It has been previously stated that the constant flow of approximately 5 mgd will be sufficient for the projected water supply needs covered by this study.

It is extremely important for accurate meter readings of water usages to be maintained daily. Also, projections should be made each year for the following year's usage so that a sufficient water supply can be maintained.

3. *Treatment*

a. *Regulations*

The City of San Saba should initiate a study of the benefits of additional treatment of the City's water supply.

The Safe Drinking Water Act (SDWA) amendments of 1986 have resulted in new regulations for surface water treatment. New regulations, called the Surface Water Treatment Rule (SWTR), became effective on January 1, 1991, and are now included in the Texas Water Commission (TWC) water quality standards. Utilities will have until July 1, 1993, to comply with the new regulations.

Treated water turbidity must be less than 0.5 NTU 95% of the time versus the old standard of 1.0 NTU.

Disinfection must be sufficient to ensure that the total treatment system will achieve at least a 99.9% inactivation of Giardia Lamblia cysts and at least 99.99% inactivation of viruses. Disinfection contact time is to be determined by a tracer study approved by TWC.

The effectiveness of a disinfection system is measured by the concentration of the disinfectant times the contact time at which 90% of the flow is retained in the system. Because of the importance of detention time in meeting the SWTR, TWC is requiring all surface water treatment plant operators to submit a tracer study to establish the actual detention time of water in the treatment system by January 1, 1993.

Additional restrictions on disinfection by-products are also planned, although the final rule has not been issued at this time. The current limit for total trihalomethanes (THM's) is 0.10 mg/L. This level might be reduced by one-half in 1993-95. The allowable levels of chlorine dioxide, chlorate, and chlorite residuals in finished water, currently at 1.0 mg/L, may also be reduced.

The purpose of the new rules is to achieve high levels of disinfection while limiting disinfection by-products. This places a greater burden on the basic treatment process to produce a finished water of low turbidity.

San Saba could benefit by exploring the use of a softening process for treating water. Softening would be effective in removing radium and hardness, and in reducing the corrosivity of the public water supply. One softening process that should be investigated is the use of ion exchange. This is an excellent process for smaller systems and can be installed on individual wells and automated, provided the water source is relatively free of turbidity that could clog the synthetic media. Adjustment of pH and corrosion control would be achieved by dosing with sodium hydroxide solution, commonly called liquid caustic (NaOH). Sodium hydroxide is also used to regenerate the ion exchange resin. Ion exchange is nearly 100 percent effective in removing radium.

The traditional process of high pH lime softening is also very effective in removing radium and hardness, and in reducing corrosivity. Generally lime softening has high operating costs associated with the large quantity of lime sludge produced. However, this process should be re-evaluated as a comparative alternative to ion exchange.

b. <u>*Water Treatment Plant*</u>

Any future water treatment plant should be constructed in the vicinity of the supply source (Mill Creek spring) and should have sufficient capacity to meet the projected maximum daily demands.

4. <u>Storage</u>

The consideration of requirements for storage facilities are based upon providing sufficient capacity in the City's system. Accordingly, the minimum requirements are as follows:

<u>Elevated Storage</u>

State Board of Insurance:

"The required capacity of elevated storage is the equivalent of 10 hours' supply, based upon the requirements of 130 gallons per 24 hours.

In the case of standpipes, only that part of the capacity which is elevated 75 feet or more above the mercantile district is to be considered, unless the fire department is equipped with an adequate number of fire department pumpers in which case that part of the capacity elevated 25 feet or more may be considered.

Elevated tanks erected subsequent to the adoption of this schedule (1974) must be elevated at least 100 feet above the mercantile district in order to secure recognition, and in no case shall the bottom of the tank be less than 100 feet above the mercantile ground elevation."

Texas Water Commission:

"Elevated storage in the amount of 100 gallons per connection is required for systems of over 2,500 connections or for systems where a minimum residual pressure of 20 psi under peak design conditions or 35 psi under normal operating conditions cannot be maintained with a single input point."

Fire Prevention and Engineering Bureau of Texas:

"All features of water system should be sufficient in capacity to supply rates of flows for fire projections for the required duration of time during maximum daily consumption demands."

Ground or Surface Storage

State Board of Insurance:

"The capacity of the ground basin or reservoir to be based on a 24-hour supply and 130 gallons per capita, with a minimum capacity in all cases of 50,000 gallons."

Texas Water Commission:

"Total storage capacity - 200 gallons per connection with a maximum of 5.0 M.G. required."

Fire Prevention and Engineering Bureau of Texas:

"All features of water system should be sufficient in capacity to supply rates of flows for fire protection for the required duration of time during maximum daily consumption demands."

Compliance with the above standards will provide minimum capacity for storage. However, other considerations must be periodically reviewed and analyzed to be certain that the required delivery within the demand period from the storage reservoirs does not exceed their available capacities.

During a peak hourly demand condition, the size of the storage reservoirs should be sufficient so that no more than approximately 50% of the total available capacity is depleted. This will allow reserve capacity for emergency or unusual fire-flows, system maintenance, and other unforeseen or abnormal demands which could possibly occur during the highest water usage period. Therefore, only one-half of the total capacity of the elevated storage reservoirs was considered to be used for elevated storage capacity.

An analysis of the City's existing storage facilities was made to determine their adequacy in capacity to serve the present population. Based on the requirements of the State Board of Insurance, the existing reinforced concrete ground storage tank with a capacity of approximately 95,000 gallons, serving the lower level system, will provide capacity for a population of approximately 731. Similarly, the steel ground storage tank with a capacity of 79,100 gallons, serving the upper level system, will provide capacity for only 608 people.

As the water system of San Saba continues to develop, additional ground and elevated storage facilities will be required to effectively provide the additional capacity for the anticipated population.

Table No. III-4 summarizes the required and additional needed storage capacities for the City's future water system.

TABLE NO. III-4

MINIMUM REQUIREMENTS FOR STORAGE CAPACITY (GAL.)

GROUND STORAGE

Lower Level System

Year	Projected Population	Required* Capacity	Existing Capacity	(+) Excess, or (-) Deficient
1990	1,751	227,630	95,000	(-) 132,630
1998	2,000	260,000		(-) 260,000 **
2012	2,500	325,000		(-) 325,000

Upper Level System

Year	Projected Population	Required* Capacity	Existing Capacity	(+) Excess, or (-) Deficient
1990	875	113,750	79,100	(-) 34,650
1998	1,350	175,500		(-) 96,400
2012	3,000	390,000		(-) 310,900

ELEVATED STORAGE

Lower Level System

Year	Projected Population	Required* Capacity	Existing Capacity	(+) Excess, or (-) Deficient
1990	1,751	94,846	454,355	(+) 359,509
1998	2,000	108,333		(+) 346,022
2012	2,500	135,417		(+) 318,938

Upper Level System

Year	Projected Population	Required* Capacity	Existing Capacity	(+) Excess, or (-) Deficient
1990	875	47,396	475,059	(+) 427,663
1998	1,350	73,125		(+) 401,934
2012	3,000	162,500		(+) 312,559

* Based on minimum requirements of the State Board of Insurance

** Assuming concrete ground storage tank is replaced by this date

5. <u>*High Service Pumping*</u>

The capacity for pumping treated water into the system depends upon the amount of ground (surface) and elevated storage, the capacity of water supply, and the maximum water demands within the system. With all these variables in consideration, calculations are made to select the proper units that will deliver adequate flows and provide and optimum operating pressure range for the maximum and minimum demand conditions in the water system.

The minimum requirements of the State Board of Insurance, the Texas Water Commission and the Fire Prevention and Engineering Bureau of Texas for high service pumping are as follows:

State Board of Insurance:

"No city or town shall be placed in first key (i.e. Key Rate less than 41 cents) unless the waterworks system is equipped with duplicate service pumps aggregating not less than 1,000 gpm capacity."

"Minimum capacity of pumping units to be 500 gpm at 150-foot minimum pressure head each."

Texas Water Commission:

"Service pumps - two or more having a total rated capacity of 2.0 gallons per minute per connection or total capacity of 1,000 gpm and able to meet peak demand, whichever is less."

"Two or more pumps shall be installed to supply each section of the distribution system or each pressure level."

Fire Prevention and Engineering Bureau of Texas:

"All features of a water system should be sufficient in capacity to supply required rates of flows for fire protection for the required duration of time during maximum daily consumption demands."

In consideration of the above minimum standards and from experience in other water system operations, high service pumping capacity should be sized to deliver at least the approximate equivalent of maximum daily demand, plus fire-flow, with the largest pump out of service. Mechanical failure is a possibility at any time, and the largest unit is just as susceptible to failure as the smallest one. The pumps will then supply a portion of the water from ground storage, while the elevated tanks will release the remainder of the water required to meet the maximum system demand.

It is of utmost importance for meter readings of amounts of water pumped to be constantly maintained. Water usage and pumping records will serve as direct bases for design of future improvements of San Saba.

6. Distribution System

a. Water Mains

The planning for the future network of water mains (8 inches in diameter or larger) considered sizing the pipes according to the critical demands required to deliver water to a general area of development. However, the pipes and related appurtenances to serve the specific development within each loop should conform to the minimum standards recommended by the Texas Water Commission, the State Board of Insurance, and the Fire Prevention and Engineering Bureau of Texas (FPEB). Accordingly, the recommended minimum diameter for water mains in residential areas is 6 inches, and the mains should be looped to provide flow from at least two (2) directions.

The FPEB recommends that, when the 6-inch diameter mains exceed intervals of 600 feet between cross-connecting mains or where dead-end lines exist, 8-inch diameter and larger mains should be installed. Further, the State Board of Insurance and the FPEB recommend that the water mains in all high value areas (business and industrial districts) should be not less than 8 inches in diameter and looped.

The State Board of Insurance states that "all portion of 6-inch looped mains in excess of 3,500 feet to be charged for." Therefore, mains 8 inches in diameter must be cross-connected each way at intervals not to exceed 3,500 feet.

In order to maintain desirable pressures in the two separate operating planes, it is recommended that the distribution system in the lower level system operate below elevation 1,225 feet and the upper level system operate between elevations 1,200 feet and 1,300 feet.

b. Gate Valves

The importance of having sufficient gate valves in the system cannot be stressed enough. The recommendations of the FPEB provide that all mains (except major transmission mains) should be equipped with gate valves located so that the maximum length of main that must be removed from service for repairs, connections, or breaks will not exceed 500 feet in high-value districts (business and industrial areas) nor more than 800 feet elsewhere. The major transmission mains should be spaced so that no length greater than one-fourth mile be affected by a single break.

A program should be implemented for improving the valving in the existing system where the spacing is inadequate. The valve improvement program should also include a regular routine of checking and operating each valve. Where valves are found to be ineffective, inoperative, or difficult to operate, they should be serviced, repaired, or replaced as their conditions warrant.

One very essential part of the valve program is in the recording of the valve locations, condition, manufacturer, date of installation, and operations. Many thousands of dollars are lost in water systems because valve operations are neglected or valve locations are completely lost under paving overlays.

The program for operation and maintaining the records of each valve in the system is a major undertaking. However, the knowledge of where one valve is located when it is needed will very often justify the effort.

c. Fire Hydrants

The following paragraph, concerning fire hydrants, is an excerpt from the "Key Rate Schedule for Grading Cities and Towns of Texas With Reference to Their Defenses and Physical Conditions", published by the State Board of Insurance in Austin, Texas, 1974.

> *"Standard three-way hydrants are to have six-inch or larger connection to mains with a minimum of five-inch valve opening. Hydrants to be properly located so there will be a fire hydrant every 300 feet in mercantile and industrial areas and every 600 feet in residential areas, so that every building in*

> *the city limits will be within 500 feet of a standard fire hydrant. Hydrants must be equipped with the National Standard hose threads. Hydrants to be maintained in good operating condition and to be inspected, oiled, greased, and flushed every three months, and painted a distinctive color at least once a year."*

According to the recommendations of the Fire Prevention and Engineering Bureau of Texas, fire hydrants should comply with the following criteria.

> *"Hydrants should conform with American Water Works Association Standards and have at least two 2-1/2-inch outlets and a large pumper connection with National Standard hose threads. Hydrant valve openings should be minimum 5-inch and hydrants should be of a type that the valve will remain closed when the barrel is broken. All connections from mains to hydrants should be of minimum size 6-inch pipe, and all connections should be valved."*

Fire hydrants should be installed to provide for adequate coverage of each structure in the City. Each fire hydrant should be installed at the proper height so as to be easily reached and convenient for attaching fire hoses.

A program in maintaining proper care and inspection of the fire hydrants at regular intervals during the year is recommended. Records should be kept as each hydrant is checked, noting the location, the manufacturer, the operating condition and especially items concerning repairs or replacement of parts. Such a program of routine inspections is of great value to the system with respect to the insurance rating as well as to the protection of the citizens' properties.

D. Conclusions and Recommendations

The following statements of conclusions and recommendations are presented to aid in the decisions that must be periodically made for scheduling improvements to meet the anticipated demands of the waterworks system.

The recommendations included herein regarding capacity requirements are intended as a minimum. At the time the proposed improvements are planned for construction, an evaluation of proposed capacity and cost as well as development trends should be made to insure the most efficient installation.

1. Supply

- a. *The City will continue to receive its treated water supply from the Mill Creek spring.*
- b. *The anticipated maximum daily demand is 1.90 mgd in Year 1998 and 3.27 mgd in Year 2012.*
- c. *Projections should be made annually of the next year's water usage to assure an adequate water supply for the City.*
- d. *The City should ascertain that sufficient water rights have been obtained to assure a long range water supply.*

2. Treatment

- a. *Water is produced from four shallow wells and is used directly without treatment other than chlorination for disinfection.*
- b. *The present water supply is high in dissolved* CO_2 *and shows traces of radium.*
- c. *The water supply of the City must meet the regulations of the Safe Drinking Water Act*

Amendment of 1986 and the Texas Surface Water Treatment Rule, especially as they apply to turbidity and contaminant removals.

d. *The City should initiate a study of the benefits of additional treatment of its water supply.*

3. <u>*Storage*</u>

a. <u>*Ground*</u>

1. *A reinforced concrete tank with a capacity of approximately 95,000 gallons located at the Mill Pond, serves the lower level system; this tank shows construction problems and allows seepage.*
2. *The upper level system is served by a steel ground storage tank with a capacity of approximately 79,100 gallons, also located at the Mill Pond.*
3. *According to the requirements of the State Board of Insurance, the City is deficient in ground storage and is being charged on its key rate because of this deficiency.*
4. *If a pumping station is constructed at the Silver Elevated Reservoir and a portion of this reservoir is converted to ground storage for the upper level system, then it is felt that the required capacity of a new ground storage reservoir can be kept to a minimum.*
5. *It is recommended that a new ground storage tank, with a minimum capacity of 325,000 gallons, be constructed near the Mill Pond.*

b. Elevated

(1) *The Silver Elevated Reservoir, with a capacity of approximately 454,355 gallons, is located in the southwestern sector of the City and serves to furnish pressure for the lower level system.*

(2) *The upper level system is served by the Gold Elevated Reservoir, which has a capacity of approximately 475,059 gallons; it is also located in the southwestern sector.*

(3) *The City presently has an excess of elevated storage, and, if a new pumping station is constructed at the Silver Elevated Reservoir, it is felt that some of this can be converted to ground storage for the upper level system.*

c. High Service Pumping

(1) *Both the lower level system and the upper level system are served by two high service pumps each.*

(2) *With the largest pump out of service in each pumping station, the available pumping capacity for the lower level system is 1.08 mgd and 0.72 mgd for the upper level system.*

(3) *The projected pumping capacity for the Year 2012 is at the rate of 7.59 mgd for the entire system.*

(4) *It is recommended that additions be made to both existing high service pumping stations to supply the required capacity to meet the projected maximum daily demand plus fire-flow.*

(5) *It is recommended that a new housing be constructed for the pumping station serving the upper level system, using masonry construction with a reinforced concrete roof.*

(6) *A new high service pumping station is recommended for construction at the Silver Elevated Reservoir to pump additional water into the upper level system from this storage tank.*

<u>4. Distribution System</u>

a. *The existing water distribution system is comprised of mains 8 inches through 2 inches in diameter.*

b. *The two existing 4-inch water mains on Wallace and Dry Streets should be replaced or converted strictly to service mains.*

c. *Since U.S. Highway 190 on Wallace street fills almost all the right-of-way, it is recommended that the 4-inch water main in the street be converted principally to a domestic service line; proposed cross-connecting 8-inch and 6-inch mains on Second and Tenth Streets, along with cross-connecting mains in other streets, will furnish fire protection along Wallace Street.*

d. *The 4-inch main on Dry Street from Cherokee Street to Seventh Street should be replaced with 8-inch and 6-inch mains, as shown on the Waterworks Plan.*

e. *New 8-inch and 6-inch mains are recommended for installation on Thornton, Clinic, Murray, Lafayette, Mound, and Limestone Streets.*

f. *Water mains of the sizes shown on the Waterworks Plan should be planned and installed in accordance with the requirements of the Texas Water Commission and the State Board of Insurance to meet initial as well as future water distribution needs.*

g. *All water mains should be looped to provide water service from at least two (2) directions.*

h. *Large diameter water transmission mains (8-inch diameter and larger) should be scheduled for construction in major capital improvements programs or as parts of new developments.*

i. *Water mains 8 inches in diameter or larger should be installed not to exceed 3,500 feet in both directions.*

j. *Ordinances should be developed and adopted providing for extensions of water mains to new subdivisions, payment of impact fees for connections to existing water mains, and participation in oversizing of water mains to conform to the City's proposed distribution system.*

k. *It is recommended that a routine schedule be implemented for operating, maintaining, and recording the condition of all gate valves and fire hydrants in the system.*

IV. WASTEWATER SYSTEM

A. General

Definition of Terms

The following definitions are presented to clarify the terms used in this study.

Wastewater - water carrying wastes from residences, businesses, and industries that are a mixture of water and dissolved or suspended solids (i.e. sanitary sewage).

Wastewater System - a complete system of pipes, manholes, cleanouts, pumping stations, and treatment facilities designed for the collection, transporting, and treatment of wastewater discharged from residences, businesses, and industries.

Sanitary Sewage - the water-carried wastes which originate in the sanitary conveniences of a dwelling, business establishment, factory, or institution (i.e. wastewater).

Storm Sewage - the water-carried wastes flowing in sewers, diluted by rain water during or after a period of rainfall.

Infiltration - the ground water which gains entrance into the sewers through joints, connections, defective pipe, manhole walls, etc., as differentiated from surface run-off.

Inflow - the water which gains entrance into a sewer system from such sources as connections to roof and foundation drains, catch basins, cross-connections to storm sewer systems, manhole covers, etc.

<u>Infiltration/Inflow</u> - the total quantity of water from both infiltration and inflow without distinguishing the source.

<u>A Sewer</u> - a pipe or conduit used for the purpose of conveying sewage. There are three general classifications of sewers:

a. *<u>A Sanitary Sewer</u> is one designed to carry sanitary sewage only. In many cases, it will carry industrial wastes produced in the area it serves.*

b. *<u>A Storm Sewer</u> carries storm water run-off and other similar wastes not including sanitary sewage.*

c. *<u>A Combined Sewer</u> is designed to carry domestic sewage, industrial wastes, and storm water run-off in a single conduit.*

<u>Sewerage</u> - a term used to designate the service provided for the collection, transportation, and pumping of sanitary sewage and industrial wastes.

<u>Sewage Treatment Plant</u> - a comprehensive term encompassing the arrangement of devices and structures for treating sewage and industrial wastes and sludge (wastewater).

<u>An Interceptor Sewer</u> - a sewer main which receives wastewater flow from a number of transverse sewer outlets (collecting system) for transmission to an outfall sewer or to a point for treatment or disposal.

An Outfall Sewer - *a sewer main which receives the sewage from a collecting system or an interceptor sewer pipe and carries it to a point of treatment and final discharge.*

Sewage Treatment - *an artificial process to which sewage is subjected in order to remove or alter its objectionable constituents so as to render the sewage less dangerous or offensive.*

Sewage Disposal - *the act of disposing of sewage by any method. It may be accomplished with or without previous treatment of the sewage.*

B. Sewage Characteristics and Flows

1. *Characteristics*

The City's sewerage system provides service to residential, commercial, and industrial development.

The domestic wastewater is that sewage that can be attributed to residences and commercial establishments and is quite often expressed as a certain percentage of water usage. Domestic sewage or wastewater is usually of normal strength and presents no special problems in collection or treatment.

Industrial wastewater is comprised of the discharge from establishments engaged in the various aspects of processing or producing some material or product. Many times this type of waste is of a nature that requires special processes and equipment for sufficient treatment before it can be safely discharged into a stream. When this type of *wastewater is discharged into a sewage collection system at full strength and in appreciable quantities, the pipe lines and pump stations can suffer damage, and the chemical-biological composition of the sewage entering the treatment plant may necessitate changes in the treatment operations.*

Unlike domestic sewage, which usually has fairly constant characteristics, industrial wastes will vary according to the type of industrial process, time of day, day of the week, season of the year, volume of business, and numerous other conditions. Consideration should be constantly given to planning for pre-treatment of industrial wastes. Of course, the location, type, and capacity of the pre-treatment facilities will be according to the specific needs at each industrial site.

Infiltration/inflow is that part of the wastewater flow that comes from storm water run-off and ground water. This water enters the sewage collection system by leakage through faulty pipe joints, manholes, cracked pipe and any connections that may not be watertight. All sewage collection systems have some infiltration/inflow because it has not been economically feasible to build and maintain a watertight sewage collection system, except in areas where the sewer mains are below the ground water table.

2. Flows

In analyzing the principal sewer mains in the collection system, projected peak flows were routed through the system, using Manning's Formula for *flow of water by gravity through pipe. Manning's Formula is:*

$$V = \frac{1.486}{n} \times R^{2/3} \times S^{1/2},$$

where: V = velocity;
n = coefficient of roughness;
R = hydraulic radius; and,
S = slope ratio.

The coefficient of roughness "n" was assumed to be 0.013, which is believed to be an average, typical of the entire system.

Experience has shown that the amount of water used by the customer which normally finds its way back into the sewer system is approximately 75 percent of the average daily per capita water consumption.

It is anticipated that 160 gallons per capita per day will return as sewage by Year 1998 and 165 by Year 2012. For purposes of this study, 165 gpcd of sewage flow will be used as the projected average wastewater flow, excluding any allowances for infiltration/inflow, for the planning period outlined herein. High?

It is important that all future plans and specifications for sewer improvements in San Saba contain a clause limiting the amount of infiltration which will be tolerated and stating that all subdividers and persons charged with the inspection and acceptance of house sewer connections must enforce the requirements of this clause.

For the purpose of this report, a maximum rate of infiltration/inflow of 1,000 gallons per acre per day was used, which is in the range of flow rates determined in other similar cities.

In the analysis of the system of sanitary sewer mains, average flows do not represent the flows which the mains should be expected to handle. The sewer mains should be designed to carry the projected peak flows which would occur in the drainage area being served. The peak flows would include all wastewater contributed from domestic, commercial, and industrial developments plus allowances for infiltration/inflow.

The peak domestic sewage flows for the mains have been determined by establishing a ratio between the peak and the average flows, depending upon the size of the drainage area and the population served by the sewer main. This ratio has been calculated from studies made in other areas at a maximum of five (5) times the average flow for small areas. As the size of the area to be served increases, this ratio gradually decreases to a minimum of one and one-half (1.5) times the average flow for very large areas. For purposes of this report, peak flows are based on the Babbitt Formula for peak to average relationship. The Babbitt Formula is:

$$M = 5/P^{0.2}$$

where: M = ratio of maximum to average rate of flow; and,
P = contributing population in 1,000's.

This ratio is graphically shown by FIGURE NO. IV-1 on the following page.

C. Existing Wastewater System

1. Collection System

The collection and transmission of sewage is principally accomplished by a gravity flow system which consists of over 22 miles of pipes ranging in size from 6 inches through 16 inches in diameter. The majority of the collection system, however, is comprised of 6-inch through 12-inch diameter mains.

The outfall trunk sewer, which was installed in approximately 1928 to convey wastewater from the collection system to the old treatment plant, is approximately 6,700 feet long and was installed on a grade that is too flat to maintain cleansing velocities. A new main, 16 inches in diameter, was recently installed between the old treatment plant and the new one now under construction.

There are three (3) sewage lift stations currently operating in the San Saba wastewater collection system. An inventory of the sewage lift stations includes the following:

TABLE NO. IV-4

EXISTING SEWAGE LIFT STATIONS

Location	No. of Pumps	Reported Capacity (Each)	Force Main Size
At First & Church Streets	2	150 gpm	4"
Live Oak & 10th Ave.	2	100 gpm	6"
Prison Site	2	300 gpm	6"

For investigation purposes, the collection system was divided into major service areas as they presently exist. Using the per capita flow criteria included in this study, projected peak wastewater flows that will be contributed within each drainage or service area were checked against the estimated capacity of the existing sewer system. The grades and sizes of mains shown on the original constructions plans were used.

Several areas of the smaller diameter mains (6-inch through 10-inch diameter) in the collection system are causing a considerable amount of added expense to maintain their ability to serve the customers. Many of the mains are old and deteriorated, and, because of the roots entering the pipe joints and cracks, frequent stoppages occur. In some areas, the grades for these smaller collector mains are not adequate to carry the sewage flows that have accumulated through the past years from the increasing number of service lateral connections.

The existing sewer mains west of Fentress Street and south of Brown Street have caused considerable maintenance problems in recent years. Also, sections of 6-inch lines in Live Oak, Buffington, and Water streets evidently have deteriorated and are in need of replacement.

A program for rehabilitating, replacing, or rerouting those mains that are causing the greatest amount of maintenance problems and expense to the City should be implemented. The improvement program should include a sequence of construction, based upon an assigned priority for each segment.

2. Wastewater Treatment

The City of San Saba now operates a wastewater treatment plant which was constructed in about 1928, located approximately 1-1/2 miles east of the City.

D. Proposed Wastewater System

1. Collection System

The improvements to the existing collection system should be considered with the following objectives in mind.

a. Provide relief to mains that are presently estimated to be operating under or near overload conditions.

b. Replace and/or rehabilitate existing sewage lift stations, especially those that are inadequately equipped.

c. Replace broken or deteriorated pipe and mains having less than minimum grades that would not provide cleansing velocities.

d. Service existing developed areas not having sewage service.

e. Provide the necessary additional capacity in outfall sewers to carry sewage flow to the proposed treatment facilities.

The overall objective in the preparation of a sewer plan for San Saba is to present a general guide for the future development of the City's sewage collection system which can be integrated with the future growth of the City and its surrounding areas. Due to the large amount of relatively open or undeveloped land which exists in the areas surrounding the City, recommendations for initial improvements should be confined to the existing areas of development and to those projects which justify immediate attention.

As the need arises to construct future sewer mains in the locations shown, a detailed study should then be made of that specific area in order to determine the pipe size, alignment, expenditure, and the type of development and sewage flow that the area is expected to experience. Due to the large size of some drainage areas and small amount of development, it is highly probable that one or more intermediate steps or phases of construction may be required in the interim period prior to accomplishing the total plan for the future outfall sewer mains; however, with an overall plan as a guide, there should be little *difficulty in constructing facilities now which would be compatible with future growth and expansion.*

Sewer mains shown on the Wastewater Plan (FIGURE NO. IV-2) indicate the locations and sizes of mains for the anticipated flows from drainage areas within the Study Area. Since the topography of the City indicates slopes to the north in the western portion of the City, interceptor sewers are proposed in Murray and Hope Streets and in Eighth and Ninth Streets. Also, an interceptor sewer is planned along the south side of the A. T. & S. F. Railroad to convey wastewater from the southwestern and western sectors to the outfall sewer. To prevent the existing sewers on Lookout Street from becoming overloaded, an additional interceptor sewer is proposed in Cherokee Street from Dry Street to the A. T. & S. F. Railroad.

A new outfall trunk sewer with sufficient grade and capacity is proposed to be installed from the collection system to the new wastewater treatment plant. A new lift station will undoubtedly be needed to lift the wastewater to the new plant.

Gravity sewers are proposed to eventually relieve the lift stations on Live Oak and First Streets.

The design for the new sewer mains should conform to the criteria of the Texas Water Commission, and particular attention should be given to the minimum grades that provide cleansing velocities (two feet per second or greater). It is recommended that the following sizes of pipe should be designed and constructed with the minimum grade indicated.

TABLE NO. IV-2

RECOMMENDED MINIMUM SEWER MAIN GRADES

Pipe Diameter (I.D. in inches)	**Minimum Grade (Ft./100 Ft. of Pipe)**	**Q* m.g.d.**	**Velocity* (Ft./Sec.)**
6	0.50	0.259	2.02
8	0.34	0.458	2.03
10	0.26	0.735	2.05
12	0.20	1.04	2.04
15	0.16	1.67	2.11
18	0.12	2.35	2.06
21	0.10	3.24	2.08
24	0.08	4.14	2.04
27	0.07	5.26	2.05
30	0.06	6.51	2.05
33	0.05	7.87	2.05
36	0.05	9.65	2.11
39	0.05	11.70	2.18

* Based on n = 0.013

All mains - 8" min

Except in locations where a sewer main is to serve a short dead-end street, all future sewer mains installed in the City should be a minimum of 8 inches in diameter to decrease stoppages and maintenance costs.

The manholes in a sewerage collection system provide a convenient access to the sewer pipe for inspection of flows and maintenance purposes; however, if the manhole is poorly constructed or the spacing is not properly made, the value of the manhole is lost. Again, the Texas

Water Commission recommends specific criteria for the design and construction of manholes in the sewerage collection system. These recommendations should be reviewed and adopted as minimum standards of the City. A recommended maximum spacing and diameter for manholes are shown in TABLE NO. IV-3, according to the largest pipe in the manhole.

TABLE NO. IV-3

DESIGN CRITERIA FOR SANITARY SEWER MANHOLES

Pipe Diameter	Maximum Spacing	Manhole Diameter
8"	500'	4.0'
10"	500'	4.0'
12"	500'	4.5'
15"	500'	4.5'
18"	500'	4.5'
21"	500'	5.0'
24"	500'	5.0'
27"	500'	5.0'
30"	500'	5.0'
36"	500'	6.0'
39"	500'	6.0'
42"	500'	6.0'

Where sewer mains will not be extended beyond a given point, it is recommended that a cleanout be constructed at the end of the pipe. This will, at least, provide a means for cleaning the pipe, if it becomes necessary.

2. Wastewater System

Nearing completion at the present time is a new treatment plant located approximately 1,000 feet south of the old one. The new facility will consist of a primary lift station, one facultative lagoon, and two stabilization ponds.

The new plant was designed to treat an average flow of 0.37 mgd and to produce an effluent of 30 mg/l BOD_5 and 90 mg/l TSS. 0.24 mgd of the effluent from the plant are to be used to irrigate 65 acres of pasture land as well as the municipal golf course. The remaining 0.13 mgd of effluent will be discharged into the San Saba River.

Table No. IV-4 projects the average anticipated sewage flows for the City's periodic increments of growth.

TABLE NO. IV-4

PROJECTED AVERAGE SEWAGE FLOWS (mgd)

Year	Projected Population Equivalent	Average Sewage Flows
1998	3,350	0.54
2012	5,500	1.91

E. Conclusions and Recommendations

The following statements of conclusions and recommendations are presented to aid in the decisions that must be periodically made for scheduling improvements to meet the anticipated demands of the wastewater system.

1. *Collection System*

a. *The existing sewerage system of San Saba is developed in one principal drainage area and contains approximately 24 miles of sewer pipes ranging in size from 6 inches to 16 inches in diameter, including manholes, cleanouts, and service laterals.*

b. *There are three (3) sewage lift stations currently being operated within the collection system.*

c. *All the industrial waste discharges are currently being carried through the collection system.*

d. *It is apparent that excessive infiltration/inflow sources exist within the collection system.*

e. *Further studies, such as an infiltration/inflow analysis, should be made to determine the locations of these extraneous water sources and alternatives for elimination.*

f. *It is recommended that the City investigate the extent of needed construction to repair, replace or relocate those sections of the major interceptor and outfall mains and manholes that are known to allow the entry of extraneous water through faulty joints, cracked pipe, manhole walls, covers, cleanouts, etc.*

g. *It is recommended that the deteriorated smaller diameter (6-inch through 10-inch) sewer mains be replaced as part of an annual program of improvements, or possibly a capital improvements program.*

h. *It is recommended that the City continue to adhere to the design criteria of the Texas Water Commission for sewerage systems as minimum standards.*

i. *It is recommended that a sampling program for the waste discharged from each industry be implemented to document the characteristics and potential problems that may be encountered.*

j. *It is recommended that the existing and any future lift stations be equipped with a minimum of two pumps, with the capacity of the lift station equal to the design flows with the largest pump out of service.*

k. *It is recommended that existing sewage lift stations be eliminated whenever possible.*

l. *It is recommended that manholes located in all floodprone areas be constructed with water-tight covers or with elevations of the tops of manhole covers set at a minimum of one foot above the 100-year flood plain, whichever is the most reasonable for maintenance purposes.*

m. *It is recommended that, where proposed highways and thoroughfares are planned and where grades can be determined, encasement pipes be installed to provide for future crossings and extensions to the sewage collection system.*

n. *The following major sanitary sewer mains and improvements should be installed as shown.*

   (1) 24-inch diameter outfall sewer main, lift station, and 16-inch diameter force main from the collection system on Lookout Street to the new wastewater treatment plant

(2) 18-inch, 15-inch, and 12-inch diameter interceptor sewers along the south side of the A. T. & S. F. Railroad from Lookout Street to Hope Street

(3) 10-inch interceptor sewer in Cherokee Street from A. T. & S. F. Railroad to Dry Street.

(4) 10-inch diameter interceptor sewer in Tenth and Ninth Streets from Woodlawn Street to Church Street

(5) 10-inch interceptor sewer in Hope and Murray Streets from the A. T. & S. F. Railroad to Dry Street

(6) 8-inch sewer main in Church Street from High Street to First Street

(7) 8-inch sewer main in Live Oak Street from Dry Street to Hill Street

(8) 8-inch sewer main in Buffington Street from Dry Street to Church Street

(9) 8-inch sewer main in Water Street from Dry Street to Annex Street

(10) 10-inch sewer main from Seider and Lookout Streets to Live Oak Street and Tenth Avenue.

2. Wastewater Treatment

It is recommended that sewage flows and characteristics as well as required design criteria be closely monitored so that proper planning, design, and construction of expansion of wastewater treatment facilities can be accomplished prior to need.

V. PRIORITIES AND COST PROJECTIONS

A. General

In summary of the recommendations outlined in this report, a program of improvements and cost projections were developed for construction to occur in incremental segments. The cost projections are based on current prices and include allowances for contingencies and engineering; however, the projections of costs should be constantly reviewed and updated since the rate of inflation may significantly affect the total project cost. The project costs presented herein do not include the costs of land and/or easements.

B. Construction Priorities

In scheduling the initial phase of proposed projects, consideration was given to constructing first those improvements most urgently needed. These improvements consist primarily of constructing a new ground storage tank at the Mill Pond site, additional high service pumps at the Mill Pond site, new housing for the two existing pumps for the upper level system, a new high service pump station at the Silver Elevated Reservoir, water and sanitary sewer mains throughout the two systems, a new outfall sewer main, lift station and force main, and new interceptor sewers. The improvements to be considered in the subsequent phases of work involve several major items of importance to enhance both the waterworks and wastewater systems' overall operation and efficiency as well as provide capacity for future growth.

Any other improvements for the water and wastewater systems will need to be included to relieve any problems in general maintenance, low water pressure, poor water distribution and circulation, and inadequacies in the wastewater collection system. Each phase of improvements *thereafter should have allowances for a continuing program of replacing older mains and alleviation of substandard conditions in the waterworks and wastewater systems.*

Where the planning for the water and wastewater systems show the proposed diameters, the sizes represent the total capacity needed and do not necessarily indicate the diameters that must be constructed at one time.

Parallel mains of smaller diameters may be installed to provide the equivalent capacity of a single larger main. This will, in some areas, allow for constructing the system in stages or phases, particularly in areas along highways and thoroughfares where parallel mains will be needed. Where proposed mains are shown to follow the alignment of an existing major main, the proposed main is to be sized according to what capacity the existing main will provide towards the total capacity required.

Those major items proposed for immediate construction should be scheduled as soon as the improvements can be authorized and financial arrangements can be made. Also, additional property should be reserved and acquired where it is evident that the future improvements (storage tanks, pumping stations, lift stations, transmission mains, outfall sewers, force mains, etc.) will require the space.

To keep the plan active beyond the implementation of the initial capital improvements presented herein, an assessment of the past accomplishments and future needs should continue on a regular annual basis, even though this plan is laid out in incremental stages. This yearly re-evaluation time of the improvements completed and those needed will be extremely important for purposes of *updating cost projections, budgeting, and establishing the priorities for the next year's improvements.*

C. Capital Improvements and Cost Projections

On the following pages is presented an outline of recommended capital improvements and their cost projections. The initial phase of improvements was considered to have the highest priority for the City's current needs.

1992 - 1998

Waterworks		
1.	Conduct a detailed study on treatment of water from the Mill Creek spring	$ 10,000
2.	Construct a new ground storage tank at the Mill Pond site with a minimum capacity of 325,000 gallons	150,000
3.	Install additional pumps at the lower level system pumping station to increase its capacity to 4 mgd	150,000
4.	Install a new masonry housing around the high service pumps at the upper level system pumping station at the Mill Pond site	15,000
5.	Construct a new high service pumping station with a minimum capacity of 2.5 mgd at the Silver Elevated Reservoir to serve the upper level system	150,000
6.	Install 2,800 L.F. of 8" and 6" water mains in Dry Street from Seventh Street to Cherokee Street	90,000
7.	Install 2,900 L.F. of 8" water main in 10th & 9th Streets from Dry Street to Pierce Street	120,000
8.	Install 1,300 L.F. of 6" water main in Murray and Lafayette Streets	45,000

9.	Install 1,900 L.F. of 8" and 6" water mains in Clinic and Thornton Streets	60,000
10.	Install 1,600 L.F. of 8" and 6" water mains in Limetone and Mound Streets	60,000
11.	Replace substandard fire hydrants	50,000
	Total Waterworks	$900,000

Wastewater		
1.	Conduct an Infiltration/Inflow survey and analysis	$ 75,000
2.	Construct 5,500 L.F. of 24-inch outfall sewer, a new lift station, and 1,500 L.F. of 16-inch force main	810,000
3.	Install 6,500 L.F. of 21-inch, 18-inch, 15-inch, and 12-inch interceptor sewers along the south side of A. T. & S. F. Railroad from Lookout Street to Hope Street	490,000
4.	Install 1,400 L.F. of 10-inch interceptor sewer in Cherokee Street from A. T. & S. F. Railroad to Dry Street	90,000
5.	Install 2,600 L.F. of 10-inch interceptor sewer in 9th and 10th Streets from Woodlawn Street to Church Street	160,000
6.	Install 2,400 L.F. of 10-inch interceptor sewer in Hope and Murray Streets from A. T. & S. F. Railroad to Dry Street	150,000
7.	Install 900 L.F. of 8-inch sewer main in Church Street from High Street to First Street	45,000
8.	Install 3,600 L.F. of 10-inch and 8-inch sewer mains in Live Oak, Buffington, Water, and Brown Streets	180,000
	Total Wastewater	$2,000,000
	Total 1992-1998 Waterworks and Wastewater	$2,900,000

1998-2012

Waterworks	
1.	Construct a new water treatment plant
2.	Install new water mains from the high service pumping station at Mill Pond to Lewis Street
3.	Install other major water mains as they become necessary

Wastewater	
1.	Construct additions to the wastewater treatment plant
2.	Install extensions to east-west interceptor sewer
3.	Install sewer main to relieve the existing lift station at Lookout Street and 10th Avenue

CITY OF SAN SABA, TEXAS
Contract 90-483-881

Water and Wastewater System Study
Update August 1992

(1) Large Scale Map located in the Official File, may be copied upon request.

City of San Saba, Texas - Water Works Plan

(1) City of San Saba, Texas -Wastewater Plan

Please contact Research and Planning Fund Grants Management Division at (512) 463-7926